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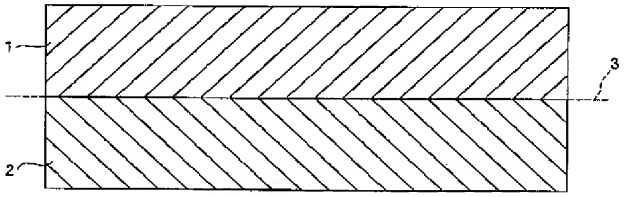
(54)【発明の名称】　チャネル波局部閉じ込め型圧電振動子およびフィルタ

(57)【要約】

【課題】　圧電基板の外周部に他の物体が直接触れても特性に変化が無く、その結果従来の圧電デバイスが必ず必要としていた振動子周辺の空隙を不要とすることによって大幅なる小型化、高信頼性を備えた圧電振動子を提供する。

【解決手段】　二枚の圧電基板を張り合わせその境界面付近に、櫛形電極を配したこと、上記二枚の圧電基板として、同一材料を結晶軸を一致させて貼り合わせたこと、上記櫛形電極として、上記圧電基板の伝播速度のより遅い導電材料を使用したことを特徴とする。



【特許請求の範囲】
【請求項１】　二枚の圧電基板を張り合わせその境界面付近に、櫛形電極を配したことを特徴とするチャネル波局部閉じ込め型圧電振動子およびフィルタ。
【請求項２】　上記二枚の圧電基板として、同一材料を結晶軸を一致させて貼り合わせたことを特徴とする請求項１記載のチャネル波局部閉じ込め型圧電振動子およびフィルタ。
【請求項３】　上記櫛形電極として、上記圧電基板の伝播速度のより遅い導電材料を使用したことを特徴とする請求項１又は２記載のチャネル波局部閉じ込め型圧電振動子およびフィルタ。
【請求項４】　上記櫛形電極と共に、上記圧電基板より伝播速度のより遅い誘電材料を配したことを特徴とする請求項１、２、３記載のチャネル波局部閉じ込め型圧電振動子およびフィルタ。
【発明の詳細な説明】
【０００１】
【発明の属する技術分野】本発明は、局部閉じ込め型圧電振動子およびフィルタに関し、詳しくは、機械的な振動を利用した圧電振動子の周囲に必須とされる物理的な空隙を不要とし、従来に比し大幅な小型化を可能とする新しいタイプの圧電振動子に関する。
【０００２】
【従来技術】圧電振動子は、数kHz から数GHz の周波数範囲に於いて、その他の電子部品に比して、共振先鋭度（Ｑ値）の素晴らしさ、および、その体積が小さいことから、携帯無線機をはじめ、一般電子応用装置に広く用いられている電子部品である。この数kHz から数GHz と言う５桁にも亘る広い周波数範囲は、一つの振動モードでは、達成できず、実際には、周波数の低い方から、輪郭振動モード、厚味振動モード、表面波振動モードが使用され、それぞれ対応した圧電振動子が実用化されている。これらの、いずれの振動モードに於いても、圧電基板の表面の一部の振動変位がある有限値を持っており、この部分が他の媒体に接触する事は、圧電振動子の本来の特性を劣化させるために、常に空隙を確保できる様な構造となっていることは、根本的常識である。図10に、その最も典型的な従来の圧電デバイスの例を示す。図10(a) は、音叉型水晶振動子の正面図、(b) は側部断面図であって、図11(a) (b) が、厚味すべり水晶振動子の場合、図12(a) (b) が、リチューム・ナイオベート表面波振動子の場合である。
【０００３】
【発明が解決しようとする課題】しかし、いずれの場合も、使用されている圧電基板の体積に比べて、ハウジング又はケースを含む圧電デバイス全体の体積が遥かに、大きいことがわかる。しかしながら、従来の圧電振動子では、上述した様に圧電基板の周囲に空隙を設ける必要があり、この空隙を確保する為に保持器が不可欠である。従って、チップ抵抗、チップ・コンデンサー、チップ・コイル等の他の一般電子部品に比べて、小型化が遅れているのが現状である。また、半導体ICのベアーチップを複数搭載することによって更なる小型化を図る時、即ち、ＭＣＭ（Multi-chip-module)構造を採用する場合に、あるいは、半導体ＩＣが形成さたシリコン基板上に搭載しようとすると、余分な空隙を含んだ圧電デバイスの体積が、これら半導体ICチップの体積に比べて格段に大きいため、ここに圧電振動子を混載する上で大きな阻害要因となっていた。本発明は、上記問題点を解決するために成されたものであって、圧電基板の外周部に他の物体が直接触れても特性に変化が無く、その結果従来の圧電デバイスが必ず必要としていた振動子周辺の空隙を不要とすることによって大幅なる小型化、高信頼性を備えた圧電振動子を提供することを目的とするものである。
【０００４】
【課題を解決する為の手段】上記目的を達成する為、請求項１の発明は、二枚の圧電基板を張り合わせその境界面付近に、櫛形電極を配したことを特徴とする。請求項２の発明は、上記二枚の圧電基板として、同一材料を結晶軸を一致させて貼り合わせたことを特徴とする。請求項３の発明は、上記櫛形電極として、上記圧電基板の伝播速度のより遅い導電材料を使用したことを特徴とする。請求項４の発明は、上記櫛形電極と共に、上記圧電基板より伝播速度のより遅い誘電材料を配したことを特徴とする。
【０００５】
【発明の実施の形態】以下、本発明を添付図面に示した形態例により詳細に説明する。まず、この発明の原理を説明する。本発明は、以下の二つの手段を具備することが必要である。
1.二枚の圧電板の境界面の付近に、機械振動を閉じ込める手段。
2.その境界面に閉じ込められた機械振動を圧電性を介して電気端子との相互作用を可能とする手段。
まず、図１を用いて、二枚の圧電基板１、２の境界面３の付近の面状領域の近傍に機械振動を閉じ込める手段について説明する。なお、圧電基板は、同時に電磁波も閉じこもるが、これは、準静的に扱い得るから、機械振動のみ考えればよいことは、周知の通りである。圧電媒質中を伝播する超音波の波動には、一つの縦波と二つの横波の合計三つの波がある。一方、有限寸法の媒質では、これら三つの波動の組み合わせによって定在波共振現象を生じ、これを利用したものが圧電振動子のような機械振動子である。
【０００６】その定在波の発生のし方により、輪郭振動、厚味振動等の様に、波動が媒体全体に存在するバルク波振動と、振動エネルギーが媒体の表面に、集中する表面波振動とがある。表面波は、バルク波と違い、一様

な圧電基板の表面に振動エネルギーが集中するものであるが、本発明は、この表面波を利用した振動子を二枚対向して張り付けることにより、圧電基板の内部の二枚の圧電基板を張り付けた境界面に、振動エネルギーを閉じ込めるものである。二つの媒質の境界面に、エネルギーを集中させて伝播する境界波は、地震学分野では既に認識されており、ストンリー波と呼ばれる境界波が存在する。この境界波は、伝播方向の変位と深さ方向の変位を持った振動形態であるが、任意の媒質の組み合わせに対しては、この境界波は存在しない。

【０００７】本発明は、この境界面として平面を採用する。この境界面に振動エネルギーを集中させるには、ホイヘンスの原理より、この境界面の面状領域の波動の伝播速度を周囲より遅くすればよく、そのためには、境界面に、この圧電基板より伝播速度の遅い材質４を、図２の様に配すればよい。伝播速度の遅い材料の一例としては、金属Auなどがあり、これを利用することができる。この様な面状領域に振動エネルギーを集中できる他の理由を説明をする。即ち、表面波振動に於いて、図３(a)の様に二層構造を持った基板において、上層５の横波の伝播速度が基板２の横波の伝播速度より遅い場合には、ラブ波が存在することは、周知である。ラブ波は、表面６で変位の深さ方向の微分成分が表面６に垂直である。即ち、応力が零と言う条件を満足する為には、変位が一番大きい表面で、図３(b) の点Ａの様に変位の深さ方向の微分成分が垂直となっている。これらの現象を踏まえて、図４(a) の様に、表面６で、二つのラブ波波動を重ね合わせる。この場合、図４(b) に示すように、表面６即ち、二つのラブ波の張り合わせ境界面では、Ａ点に示すように、変位も力も連続と成っている。従って、これらを二つ張り合わせても特性が保存されると考えられる。その結果、図４(b) の様に、二枚の圧電基板に挟まれた伝播速度の遅い面状領域付近に振動エネルギーが集中する。以上のように、伝播速度の遅い面状領域があれば、その領域付近に振動エネルギーが集中することが説明できる。本発明では、この伝播速度の遅い面状領域をつくるために、必ずしも図２の様に一様の材質で構成する必要はない。図５の様に長さＬの周期構造の材質４によって、伝播速度の遅い領域を周期的に配した構造でも、同様に摂動効果によって、この面状領域の伝播速度を遅くすることができ、従って、この面状領域付近に振動エネルギーを集中させることができる。

【０００８】以上で伝播速度の遅い周期構造の領域を配すれば面状領域に振動エネルギーを集中できることを示した。更に付け加えると、本発明において利用する局在波圧電振動子の基板は圧電性を持っているので、スチフネス負荷効果、質量負荷効果、電界短絡効果により、波動の伝播速度が変化することは、表面波波動等の場合と同じである。従って、使用される圧電材料や切断方位、および電極材質や周期構造を含めた電極の形状パラメーターにより、これらの伝播速度は変化する。

【０００９】次に、第二の手段について説明する。図５の様な、周期構造の電極により、面状領域付近に集中した振動エネルギーを圧電基板の圧電性により、電気的エネルギーとして取り出せることを説明する。この為には、従来技術で作られた同一設計の表面波振動子を、ただ単に張り合わせただけでは、本発明を実現できない。本発明では、図６の様に、一様な圧電板の中に、周期構造の電極が配置された場合を仮定すると、電気力線の分布は、連続関数であって図中の矢印線の様になる。また、仮想的な境界面３を考える。圧電材料は誘電材料としても異方性であるので、その異方性の程度に応じてこの電気力線の分布も図中の境界面３に対して上下左右に対称ではないが、大局的には、ほぼ対称であると考えられる。この電気力線により、圧電性を介して、超音波の振動が発生する。あるいは逆に、超音波の波動により、電気変位が生じ、電気端子を短絡すると電流が流れる。

【００１０】図６の電気力線は、周知のクロスフィールド成分とインフィールド成分に分けられる。そして、Ｘ軸方向の変位から引き起こされる歪みは、一様の圧電基板が境界面３の上下で材質が連続であるので、この歪みも連続となる。更に、圧電性で引き起こされる発生電荷も境界面の上下で連続になる。即ち、図６の様な一様の圧電板の中に周期構造の電極が配された場合に引き起こされる電気力線の分布は、クロスフィールド成分とインフィールド成分の両方とも、Ｘ軸方向の変位から引き起こされる歪みとは辻褄の合う場であることが分かる。同様にＹ軸方向の変位から引き起こされる歪みと、図６の様な一様の圧電板の中に周期構造の電極が配された場合に引き起こされる電気力線の分布は、クロスフィールド成分とインフィールド成分の両方とも、辻褄の合う場であることが分かる。以上、表面波振動子の場合に存在するラブ波とレイレー波に相当する波動、あるいは、これに似ている波動、およびこれらの組み合わせの波動に対応して、これに似た波動が、本発明の場合にも、二枚の境界面領域付近に存在し、櫛形電極で励振可能であることを説明した。

【００１１】実際の本発明の圧電振動子は、二枚の圧電基板を張り合わせて、上記の圧電板の特性を得る。なお、本発明は、結晶軸をそろえた同一材料の二枚の圧電基板を用いる方法が、電気機械結合係数を一番大きくする上で有効である。二枚の圧電基板を張り合わせる場合であっても、軸を合わせて張り合わせない場合には、一般には、電気機械結合係数は小さくなるが、周波数温度特性が良くなることが期待できる。更に、二枚の圧電基板を互いに別な圧電基板で構成することは、この場合の振動姿態が境界面を挟んで両側に対称性がないので、その非対称性分だけ電気機械結合係数が劣化してしまうが、この場合も、周波数温度特性の改善が期待できる。

【００１２】次に、図７を用いて、境界面領域での二次

元方向での振動エネルギーの閉込め方法について説明する。図７は、境界面領域の櫛形電極を含む面で切断した平面図である。櫛形電極は点線で示した領域７に配置されている。この部分に伝播速度の遅い電極が配されているので、前述の張り合わせ境界面領域に振動エネルギーが集中したのと同様の理由で、伝播速度の速い領域７の外側では、振動エネルギーが反射され、ここには集中しないで、領域７付近にのみ集中する。以上説明したように、本発明は、二枚の圧電板を平面上の境界面で張り合わせ、周期構造を持つ電極で圧電性を介して、機械振動を電気端子から取り出すものであるから、表面波振動子にならって、共振器結合型のフィルターやトランスバーサル型のフィルターが実現できる。

【００１３】次に、図８を用いて、本発明の具体的実施例の構造を試作工程順に説明する。圧電基板として、水晶ST板を二枚準備し，その表面をλ/50 程度まで平坦に研磨する。この内一枚を、図８(a) の様に水晶板をエッチングして幅5 μm 、深さ200nm の溝を付ける。この溝に金Auを埋める為に、全面にスパッターにて金Auを積層し、金Au薄膜をエッチングして、図８(b) の様に形成する。この段階で、反応性プラズマエッチングを行い、周波数調整を行う。この時エッチャントを変えながら、水晶基板と金Au膜の両方を段差なく平行にエッチングする必要がある。

【００１４】次に、もう一枚の圧電基板をλ/50 程度まで研磨した面同士が張り合わされるようにして、張り合わせる。この張り合わせは、２段階で行う。第一段階は、常温、常圧にて、二枚の圧電基板に5kg/cm２ の圧力を掛けて張り合わせる。この段階の接合のメカニズムは、水素結合と言われている。次に、これを450 ℃で，１時間加熱する。この段階の接合は、水の取れたイオン結合と言われており、非常に強固な接合であり、接合面から剥がれることはない。以上で、本発明の局在波モード圧電振動子が完成する。実測によれば、特性は、Ｑ値が1000であった。また、外周部を振動損失の大きいゴム状物質で押さえつけた場合のＱ値の劣化は認められなかったので、圧電基板の外周部に振動エネルギーが漏れ出ていないことになる。一方、この様に圧電基板の外周を束縛すると、従来の圧電振動子では、大幅なＱ値の劣化があるのに対し、本発明による振動子は格段の改善効果が確認できた。

【００１５】図９を用いて、その他の実施例を説明する。図９(a) は、共振器結合型のフィルタを例示しており、境界面領域の櫛形電極を含む面で切断した平面図である。伝播速度を遅くする手段を講じた二組の櫛形電極を配した部分８、９の間に、伝播速度を遅くする手段を講じない部分１０が配されている。これにより、二組の櫛形電極領域に閉じ込められた振動エネルギーが部分１０で結合し、フィルタを構成する。この場合、電極が二組であるため、最低次の対称モードと最低次の非対称モードが強勢に励振され、フィルタが構成されることは、表面波フィルタと同じである。図９(b) は、トランスバーサル型のフィルタをしており、同じく、境界面領域の櫛形電極を含む面で切断した平面図である。二組の入出力の櫛形11、12、としては、正規型を例示しているが、アポダイズ型、間引き型、等の手法は表面波フィルタの場合と同様に採用できる。

【００１６】

【発明の効果】本発明は以上説明したように、圧電基板の内部に振動エネルギーを閉じ込めることにより圧電基板の外周部のどこの面も機械的に振動していないために、空隙を必要とせずに構成することができるから、以下の効果を発揮する。

1.従来の圧電振動子が必ず必要としていた対パッケージ間の空隙を不要としたため、一般チップ部品の様に、格段の小型化が可能となった。

2.MCM （Multi-chip-module)構造や、圧電振動子を半導体IC基板上に搭載可能となった。

3.機械的構造が簡単になったので、耐振動特性、耐衝撃特性が増し、極めて高信頼性が達成できる様になった。

よって、従来の圧電振動子と全く使い勝手の違う、使いやすい圧電振動子を提供するものである。格段の小型化と高信頼化に、貢献するものである。

【００１７】

【図面の簡単な説明】

【００１８】

【図１】本発明の原理を説明する為の断面図。

【００１９】

【図２】本発明の原理を説明する為の断面図。

【００２０】

【図３】（ａ）及び（ｂ）は従来のラブ波振動子の概念図。

【００２１】

【図４】（ａ）及び（ｂ）は本発明におけるエネルギー集中の概念図。

【００２２】

【図５】本発明の周期構造の概念図。

【００２３】

【図６】本発明の電極での電気力線分布の概念図。

【００２４】

【図７】本発明の振動エネルギーの二次元方向の閉込め方法の説明図。

【００２５】

【図８】（ａ）（ｂ）及び（ｃ）は本発明の具体的一実施例の断面図。

【００２６】

【図９】（ａ）及び（ｂ）は本発明の一実施例の平面図。

【００２７】

【図１０】従来技術の圧電振動子の内部構造図であり、

(a) が音叉型水晶振動子の正面断面図、（ｂ）が側部断面図。

【００２８】

【図１１】従来の厚味すべり水晶振動子の内部構造図であり、(a) が正面断面図、（ｂ）が側部断面図。

【００２９】

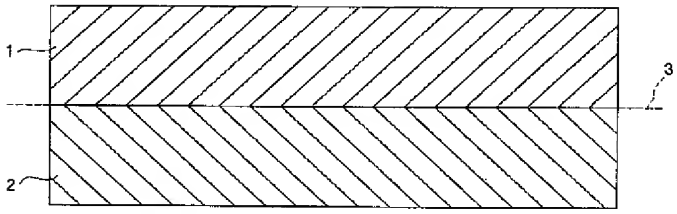
【図１２】従来のリチューム・ナイオベート表面波振動子の内部構造図であり、(a) が平面図、（ｂ）が縦断面図。

【００３０】

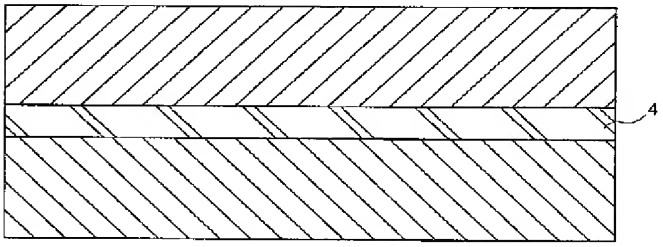
【符号の説明】

1･･･圧電板，
2･･･圧電板，
3･･･境界面，
4･･･伝播速度の遅い材質，
5･･･上層，
6･･･表面，
7･･･領域，
8,9･･･櫛形電極を配された部分，
10,11･･･櫛形電極，
12･･ケース，
13･･ベース，
14･･圧電基板，
15･･サポート，

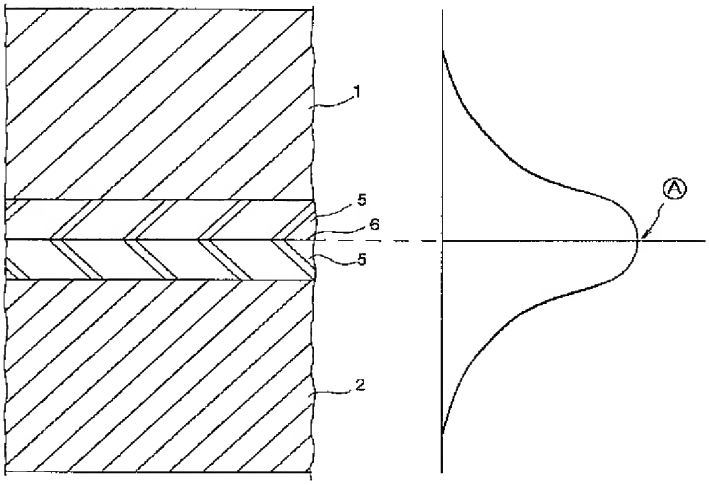
【図１】



【図２】

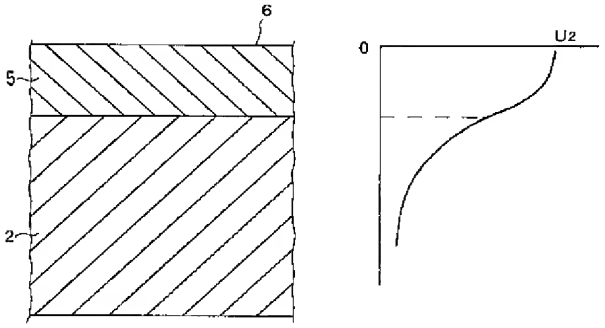


【図４】



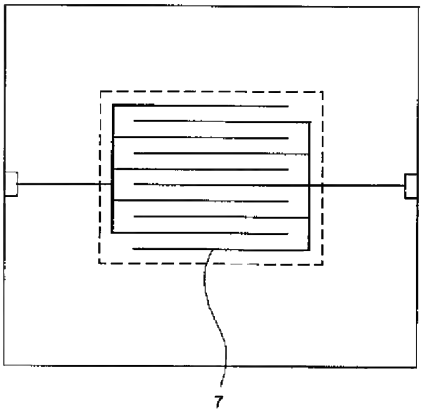
（ａ）　（ｂ）

【図３】

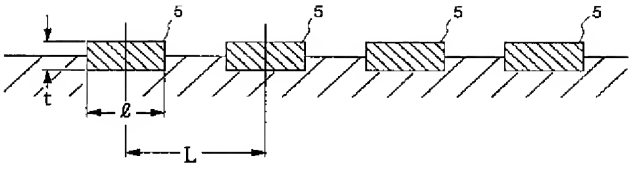


（ａ）　（ｂ）

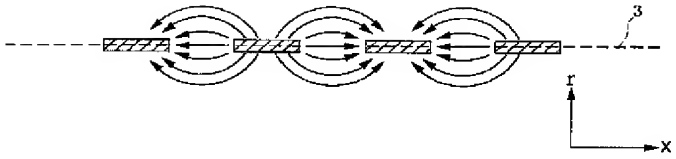
【図７】



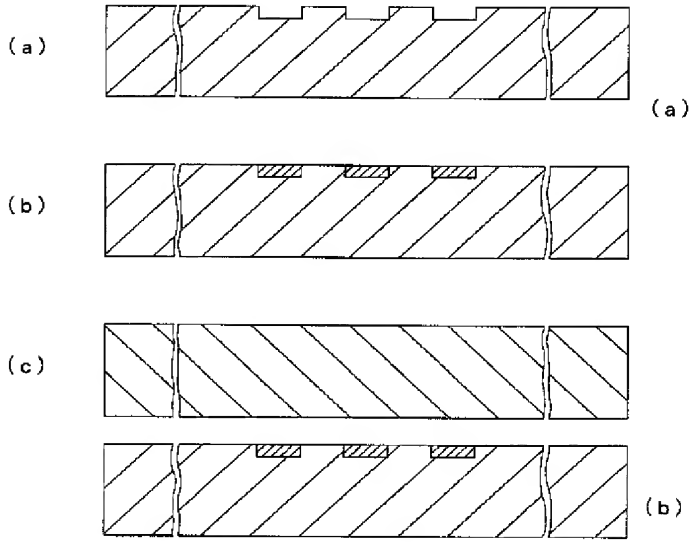
【図５】



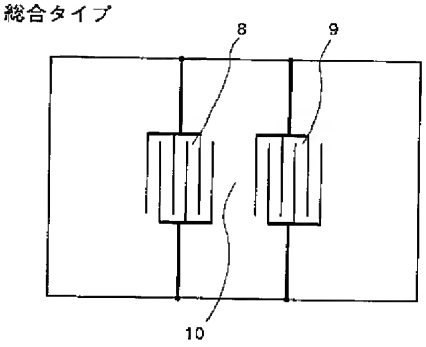
【図６】



【図８】



【図９】



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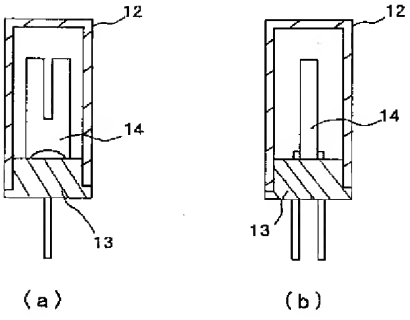
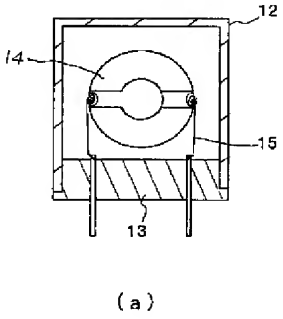
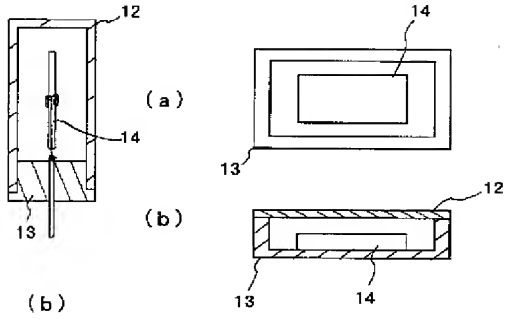


【図１１】



【図１２】



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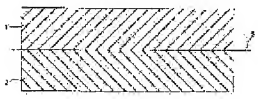
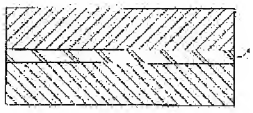
(72)Inventor : HIRAMA KOICHI

(54) CHANNEL WAVE LOCAL CONFINEMENT TYPE PIEZOELECTRIC OSCILLATOR AND FILTER





(57)Abstract:
PROBLEM TO BE SOLVED: To eliminate a need of a space around an oscillator to miniaturize a device and to improve the reliability by sticking two arbitrary substrates to each other and arranging a comb-line electrode in the vicinity of the boundary face between them.
SOLUTION: With respect to the oscillator utilizing a surface wave, two piezoelectric substrates 1 and 2 are made face each other and are stuck to each other to shut the oscillation energy in a boundary face 3 between two internal piezoelectric substrates 1 and 2. A plane is

adopted as this boundary face 3. The propagation speed of a wave motion in the plane area of this boundary face 3 is made lower than that in the peripheral area by the principle of Huygens to concentrate the oscillation energy to the boundary face 3; and this is realized by arranging a material 4, which the propagation speed is lower than that in piezoelectric substrates 1 and 2, in the boundary face 3. An example of this material 4 is metallic Au or the like, and it can be used. As the result, the oscillation energy is concentrated to the vicinity of the plane area, where the propagation speed is low, between two piezoelectric substrates 1 and 2.

LEGAL STATUS

[Date of request for examination]

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[Date of registration]

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[Date of extinction of right]

CLAIMS

[Claim(s)]
[Claim 1] The channel wave local ****** type piezoelectric transducer and filter which are characterized by having made two piezo-electric substrates rival and arranging the Kushigata electrode near [the] an interface.
[Claim 2] The channel wave local ****** type piezoelectric transducer according to claim 1 and filter which are characterized by making a crystallographic axis in agreement and sticking the same ingredient as two above-mentioned piezo-electric substrates.
[Claim 3] The channel wave local ****** type piezoelectric transducer according to claim 1 or 2 and filter which are characterized by using the later electrical conducting material of the propagation velocity of the above-mentioned piezo-electric substrate as the above-mentioned Kushigata electrodes.
[Claim 4] The channel wave local ****** type piezoelectric transducer and filter of claims 1 and 2 and three publications which are characterized by arranging the later dielectric material of propagation velocity from the above-mentioned piezo-electric substrate with the above-mentioned Kushigata electrode.

[Translation done.]

* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the piezoelectric transducer new type which makes unnecessary the physical opening made indispensable around the piezoelectric transducer which used a mechanical vibration in detail about a local ****** type piezoelectric transducer and a filter, compares with the former and enables a large

miniaturization.
[0002]
[Description of the Prior Art] a piezoelectric transducer -- several kHz from -- several GHz In a frequency range, they are the electronic parts widely used for common electronic application equipment including the field radio as compared with other electronic parts since the wonderfulness of resonance acutance of image (Q value) and its volume are small. several of these kHz from -- several GHz ** -- the large frequency range covering 5 figures to say cannot be attained by the one oscillation mode, but in fact, from the one where a frequency is lower, contour vibration mode, the thick taste oscillation mode, and the surface wave oscillation mode are used, and the piezoelectric transducer which corresponded, respectively is put in practical use. It has the finite value which has a part of vibration displacement of the front face of a piezo-electric substrate also in which these oscillation modes, and in order that that this part contacts other media may degrade the original property of a piezoelectric transducer, it is fundamental common sense to have the structure where an opening can always be secured. The example of the most typical conventional piezo-electric device is shown in drawing 10. Drawing 10 (a) The front view of a tuning fork mold quartz resonator, and (b) It is a flank sectional view and is drawing 11 (a). (b) In the case of a thick taste skid quartz resonator, it is drawing 12 (a). (b) It is the case of lithium NAIO bait surface wave vibrator.
[0003]
[Problem(s) to be Solved by the Invention] However, in any case, compared with the volume of the piezo-electric substrate currently used, it turns out that the volume of the piezo-electric whole device including housing or a case is large far. However, a cage is indispensable, in order [which was mentioned above in the conventional piezoelectric transducer] to establish an opening in the perimeter of a piezo-electric substrate like and to secure this opening. Therefore, compared with other common electronic parts, such as a chip resistor, a chip capacitor, and a chip inductor, the present condition is that the miniaturization is behind. moreover, when the semiconductor IC tended to carry on the formation **** silicon substrate when MCM (Multi-chip-module) structure was adopted or when attaining the further miniaturization by carrying two or more bare chips of a semiconductor IC namely, the volume of a piezo-electric device including an excessive opening had become a big inhibition factor, when it is markedly alike compared with the volume of these semiconductor IC chip, and loading

together a piezoelectric transducer here, since it is large. This invention is accomplished in order to solve the above-mentioned trouble, even if other bodies touch the periphery section of a piezo-electric substrate with it directly, there is no change in a property, and it aims at offering the piezoelectric transducer equipped with a large miniaturization and high-reliability by making unnecessary the opening of the vibrator circumference which the piezo-electric device of the result former surely needed.

[0004]

[Means for Solving the Problem] In order to attain the above-mentioned purpose, invention of claim 1 is characterized by having made two piezo-electric substrates rival and arranging the Kushigata electrode near [the] an interface. Invention of claim 2 is characterized by making a crystallographic axis in agreement and sticking the same ingredient as two above-mentioned piezo-electric substrates. Invention of claim 3 is characterized by using the later electrical conducting material of the propagation velocity of the above-mentioned piezo-electric substrate as the above-mentioned Kushigata electrode. Invention of claim 4 is characterized by arranging the later dielectric material of propagation velocity from the above-mentioned piezo-electric substrate with the above-mentioned Kushigata electrode.

[0005]

[Embodiment of the Invention] Hereafter, the example of a gestalt which showed this invention to the accompanying drawing explains to a detail. First, the principle of this invention is explained. This invention needs to provide the following two means.

1. Means which shuts up mechanical vibration near the interface of two piezo-electric plates.

2. Means which makes interaction with electric terminal possible for mechanical vibration confined in the interface through piezoelectric.

First, the means which shuts up mechanical vibration near the field-like field of a near [the interface 3 of two piezo-electric substrates 1 and 2] is explained using drawing 1 . in addition -- although, as for a piezo-electric substrate, an electromagnetic wave also shuts itself up in coincidence -- this -- ** -- since it can treat statically, it is well known that what is necessary is to consider only mechanical vibration. There are a total of three waves of one longitudinal wave and two transverse waves in the wave motion of the supersonic wave which spreads the inside of a piezo-electric medium. It is a mechanical vibration child like a piezoelectric transducer who produced standing wave resonance phenomena and used this with the combination of these

three wave motion by the medium of a finite dimension on the other hand.
[0006] Depending on how to carry out generating of the standing wave, there are bulk wave vibration in which the wave motion exists in the whole medium, and surface wave vibration which vibrational energy concentrates on the surface of a medium like contour vibration and thick taste vibration. Unlike a bulk wave, vibrational energy concentrates a surface wave on the front face of a uniform piezo-electric substrate, but this invention confines vibrational energy in the interface on which two piezo-electric substrates inside a piezo-electric substrate were stuck by two sheets' countering and sticking the vibrator using this surface wave. The boundary wave to which the boundary wave which is made to concentrate energy on the interface of two media, and is spread is already recognized in the seismology field, and is called a SUTONRI wave exists. Although this boundary wave is oscillatory-type voice with the variation rate of propagation, and the variation rate of the depth direction, this boundary wave does not exist to the combination of the medium of arbitration.
[0007] A flat surface is used for this invention as this interface. What is necessary is just to allot the quality of the material 4 with propagation velocity slower than this piezo-electric substrate to an interface like drawing 2 for that purpose from Huygens' principle that what is necessary is just to make the wave propagation rate of the field-like field of this interface later than a perimeter, in order to centralize vibrational energy on this interface. As an example of the late ingredient of propagation velocity, there is a metal Au etc. and this can be used. Other reasons which can concentrate vibrational energy on such a field-like field are explained. That is, it sets to surface wave vibration and is drawing 3 (a). In the substrate which had the two-layer structure like, when the propagation velocity of the transverse wave of the upper layer 5 is slower than the propagation velocity of the transverse wave of a substrate 2, it is common knowledge that a Love wave exists. The Love wave of the differential component of the depth direction of a variation rate is perpendicular to a front face 6 on a front face 6. That is, it is drawing 3 (b) in the front face where a variation rate is the largest in order for stress to satisfy the conditions called zero. The differential component of the depth direction of a variation rate is perpendicular like Point A. It is based on these phenomena and is drawing 4 (a). Two Love wave wave motion is piled up on a front face 6 like. In this case, drawing 4 (b) As shown at an A point, a variation rate and the force change with continuation in the front face 6, i.e., the lamination interface of two Love waves, so

that it may be shown. Therefore, it is thought that a property is saved even if it makes these [two] rival. Consequently, drawing 4 (b) Vibrational energy concentrates near [late] the field-like field of the propagation velocity inserted into two piezo-electric substrates like. As mentioned above, if there is a late field-like field of propagation velocity, it can explain that vibrational energy concentrates near [the] a field. In order to build the late field-like field of this propagation velocity with this invention, it is not necessary to necessarily constitute from the uniform quality of the material like drawing 2 . Like drawing 5 , with the structure which allotted the late field of propagation velocity periodically according to the quality of the material 4 of the periodic structure of die-length L, similarly, propagation velocity of this field-like field can be made late, therefore vibrational energy can be centralized near [this] a field-like field according to the perturbation effectiveness.

[0008] When allotting the field of the late periodic structure of propagation velocity above, it was shown that vibrational energy can be concentrated on a field-like field. Furthermore, if it adds, since the substrate of the localization wave piezoelectric transducer used in this invention has piezoelectric, it is the same as cases, such as surface wave wave motion, that a wave propagation rate changes with the stiffness load effectiveness, the mass load effectiveness, and electric-field shunt effects. Therefore, such propagation velocity changes with the shape parameters of an electrode including the piezoelectric material used, cutting bearing and the electrode quality of the material, or periodic structure.

[0009] Next, the second means is explained. An electrode of periodic structure like drawing 5 explains that the vibrational energy concentrated near the field-like field can be taken out as electric energy by piezoelectric [of a piezo-electric substrate]. For that, this invention is unrealizable only by making the surface wave vibrator of the same design made with the conventional technique merely rival. In this invention, if the case where the electrode of periodic structure has been arranged in a uniform piezo-electric plate is assumed like drawing 6 , distribution of line of electric force will be a continuous function, and will become like the arrow in drawing. Moreover, the imagination interface 3 is considered. Since piezoelectric material is an anisotropy also as a dielectric material, although distribution of this line of electric force is not symmetrical vertically and horizontally to the interface 3 in drawing, either, it is thought according to extent of that anisotropy that it is global almost

symmetrical. With this line of electric force, vibration of a supersonic wave occurs through piezoelectric. Or if an electric displacement arises and an electric terminal is conversely short-circuited by the wave motion of a supersonic wave, a current will flow.

[0010] The line of electric force of drawing 6 is divided into a well-known cross field component and a well-known infield component. And by the upper and lower sides of an interface 3, since the quality of the material is continuation, this distortion also becomes [a piezo-electric substrate with a uniform distortion which results from the variation rate of X shaft orientations] continuously. Furthermore, the generating charge caused by piezoelectric also becomes continuously by the upper and lower sides of an interface. Namely, as for distribution of the line of electric force caused when the electrode of periodic structure is arranged into a uniform piezo-electric plate like drawing 6 , both a cross field component and an infield component are known by that distortion which results from the variation rate of X shaft orientations is a consistent place. It turns out that distribution of distortion which results from the variation rate of Y shaft orientations similarly, and the line of electric force caused when the electrode of periodic structure is arranged into a uniform piezo-electric plate like drawing 6 is a place where both a cross field component and an infield component are consistent. In the above, corresponding to the wave motion equivalent to the Love wave which exists in the case of a surface-wave trembler, and the Rey Leh wave or the wave motion similar to this, and the wave motion of such combination, it explained that also in the case of this invention the wave motion similar to this existed near the interface field of two sheets, and could excite with the Kushigata electrode.

[0011] The piezoelectric transducer of actual this invention makes two piezo-electric substrates rival, and acquires the property of the above-mentioned piezo-electric plate. In addition, the approach of this invention using two piezo-electric substrates of the same ingredient which arranged the crystallographic axis is effective when enlarging an electromechanical coupling coefficient most. Even if it is the case where two piezo-electric substrates are made to rival, when setting a shaft and not making it rival, it can be expected that the frequency temperature characteristic will generally become good although an electromechanical coupling coefficient becomes small. Furthermore, since the oscillating style in this case does not have symmetric property in both sides across an interface, as for constituting two piezo-electric substrates of each other from an another piezo-electric substrate, only

that unsymmetrical nature can expect an improvement of the frequency temperature characteristic also in this case, although an electromechanical coupling coefficient will deteriorate.

[0012] Next, an approach to shut up the vibrational energy in the direction of two dimension in an interface field is explained using drawing 7 . Drawing 7 is the top view cut in respect of the Kushigata electrode of an interface field being included. The Kushigata electrode is arranged to the field 7 shown by the dotted line. It concentrates only on the field 7 neighborhood without reflecting vibrational energy and concentrating here on the outside of the quick field 7 of propagation velocity by the same reason as vibrational energy concentrated on the above-mentioned lamination interface field, since the late electrode of propagation velocity is arranged on this part. As explained above, since this invention takes out mechanical vibration from an electric terminal through piezoelectric with the electrode which has lamination and periodic structure for two piezo-electric plates in the interface on a flat surface, it is learned from a surface-wave trembler and can realize the filter of a resonator joint mold, and the filter of a transversal mold.

[0013] Next, the structure of the concrete example of this invention is explained in order of a prototype process using drawing 8 . Two Xtal ST plates are prepared as a piezo-electric substrate, It is the front face lambda/50 It grinds flatly to extent. Among these, about one sheet, it is drawing 8 (a). A quartz plate is etched like and it is width of face 5. mum and a depth of 200nm A slot is attached. In order to bury Gold Au into this slot, the laminating of the gold Au is carried out to the whole surface in a spatter, and a golden Au thin film is etched, and it is drawing 8 (b). It forms like. In this phase, reactant plasma etching is performed and frequency regulation is performed. It is necessary to etch both the Xtal substrate and the golden Au film in parallel without a level difference, changing etchant at this time.

[0014] Next, it is one more piezo-electric substrate lambda/50 The ground fields stretch, they are put together, make and make it rival to extent. This lamination is performed in two steps. A first stage story is 5kg/cm2 to two piezo-electric substrates at ordinary temperature and ordinary pressure. A pressure is put and is made to rival. The mechanism of junction of this phase is called hydrogen bond. Next, this is heated by 450 ** for 1 hour. Junction of this phase is called ionic bond which was able to take water, is very firm junction and does not separate from a plane of composition. Above, the localization wave mode piezoelectric transducer of this invention is completed. According to the observation,

Q value of the property was 1000. Moreover, since degradation of the Q value at the time of suppressing the periphery section with the large rubberlike substance of oscillating loss was not accepted, vibrational energy will not have leaked and come out of it to the periphery section of a piezo-electric substrate. On the other hand, when the periphery of a piezo-electric substrate was bound to this appearance, in the conventional piezoelectric transducer, the vibrator by this invention has checked the marked improvement effect to there being degradation of large Q value.

[0015] Other examples are explained using drawing 9 . Drawing 9 (a) It is the top view cut in respect of having illustrated the filter of a resonator joint mold and the Kushigata electrode of an interface field being included. The part 10 which does not adopt the means which makes propagation velocity late among the parts 8 and 9 which arranged 2 sets of Kushigata electrodes which provided the means which makes propagation velocity late is allotted. Thereby, the vibrational energy confined in 2 sets of Kushigata electrode fields joins together in a part 10, and constitutes a filter. since [in this case,] the number of electrodes is two -- the minimum -- the following symmetric mode and the minimum -- it is the same as a surface wave filter that the following antisymmetric mode is excited by stress and a filter is constituted. Drawing 9 (b) The filter of a transversal mold is carried out and it is the top view similarly cut in respect of the Kushigata electrode of an interface field being included. Although the normal mold is illustrated if it considers as Kushigata 11 and 12 of 2 sets of I/O, the technique of an APODAIZU mold, an infanticide mold, etc. is employable like the case of a surface wave filter.

[0016]

[Effect of the Invention] Since the field of what of the periphery section of a piezo-electric substrate is not vibrating mechanically by confining vibrational energy in the interior of a piezo-electric substrate, either, as explained above and this invention can be constituted, without needing an opening, it demonstrates the following effectiveness.

1. The conventional piezoelectric transducer wrote the opening during the surely needed opposite package as it is unnecessary, and the marked miniaturization of it was attained like the common chip.
2. MCM Loading on a semiconductor IC substrate was attained in structure (Multi-chip-module) and a piezoelectric transducer.
3. Since mechanical structure became easy, an oscillation characteristic-proof and an impact property-proof increase, and high-

reliability could be attained extremely.
Therefore, the conventional piezoelectric transducer and the piezoelectric transducer with which user-friendliness is completely different and which is easy to use are offered. It contributes to a marked miniaturization and a marked raise in reliance.
[0017]

[Translation done.]

* NOTICES *

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1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[0018]
[Drawing 1] The sectional view for explaining the principle of this invention.
[0019]
[Drawing 2] The sectional view for explaining the principle of this invention.
[0020]
[Drawing 3] (a) And (b) is the conceptual diagram of the conventional Love wave vibrator.
[0021]
[Drawing 4] (a) And (b) is the conceptual diagram of the energy concentration in this invention.
[0022]
[Drawing 5] The conceptual diagram of the periodic structure of this invention.
[0023]
[Drawing 6] The conceptual diagram of line-of-electric-force distribution with the electrode of this invention.
[0024]

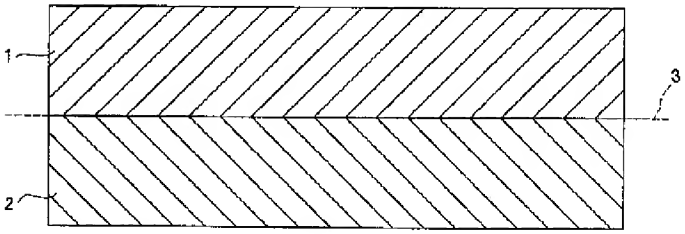
[Drawing 7] The explanatory view of an approach to shut up the direction of two dimension of the vibrational energy of this invention.
[0025]
[Drawing 8] (a), (b), and (c) are the sectional view of concrete 1 example of this invention.
[0026]
[Drawing 9] (a) And (b) is the top view of one example of this invention.
[0027]
[Drawing 10] It is the internal structure Fig. of the piezoelectric transducer of the conventional technique, and is (a). The transverse-plane sectional view of a tuning fork mold quartz resonator and (b) are a flank sectional view.
[0028]
[Drawing 11] It is the internal structure Fig. of the conventional thick taste skid quartz resonator, and is (a). A transverse-plane sectional view and (b) are a flank sectional view.
[0029]
[Drawing 12] It is the internal structure Fig. of the conventional lithium NAIO bait surface wave vibrator, and is (a). A top view and (b) are drawing of longitudinal section.
[0030]
[Description of Notations]
1 ... Piezo-electric plate,
2 ... Piezo-electric plate,
3 ... Interface,
4 ... The late quality of the material of propagation velocity,
5 ... Upper layer,
6 ... Front face,
7 ... Field,
8 9 ... Part which had the Kushigata electrode arranged,
10 11 ... Kushigata electrode,
12 .. Case,
13 .. Base,
14 .. Piezo-electric substrate,
15 .. Support,

[Translation done.]

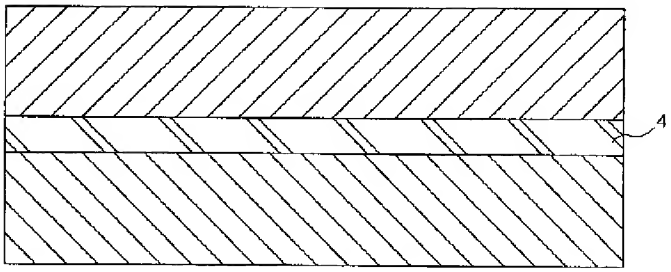
* NOTICES *

DRAWINGS

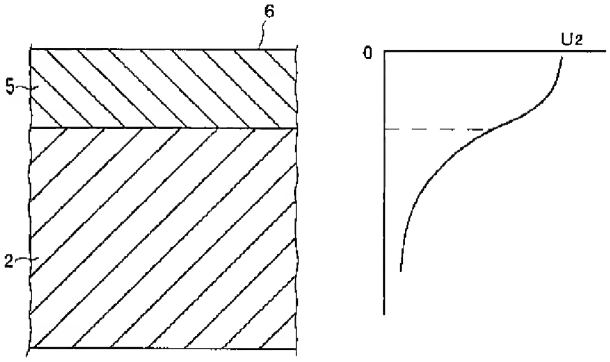
[Drawing 1]



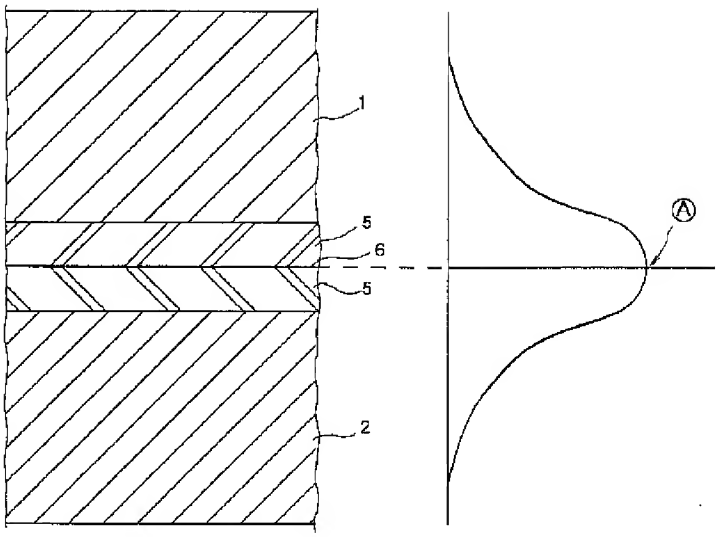
[Drawing 2]



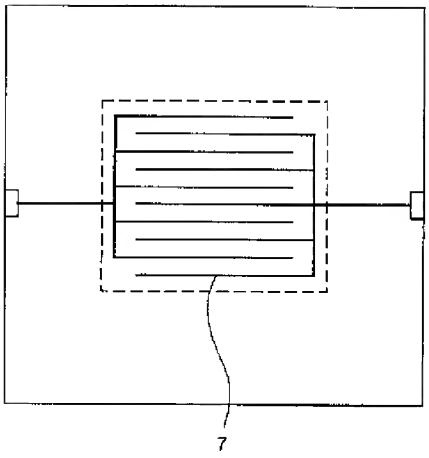
[Drawing 3]



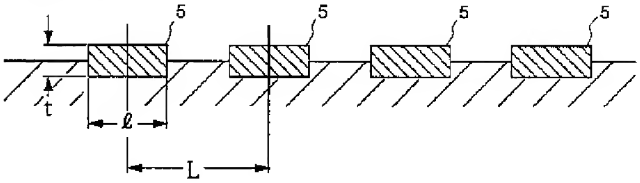
[Drawing 4]



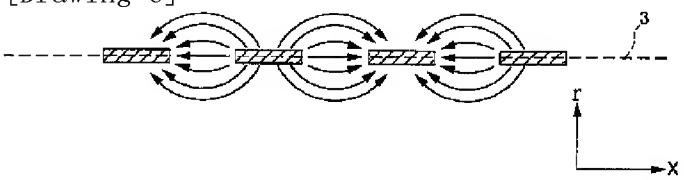
[Drawing 7]



[Drawing 5]

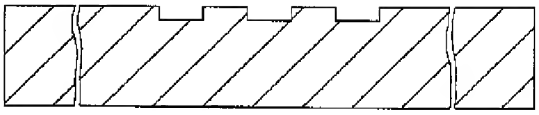


[Drawing 6]

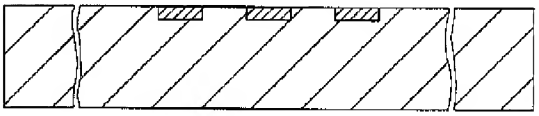


[Drawing 8]

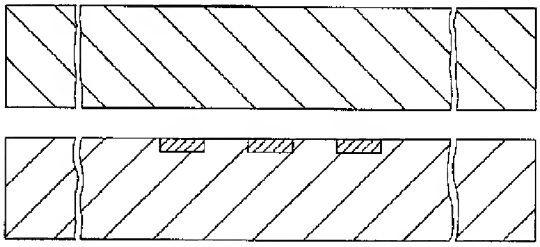
(a)



(b)



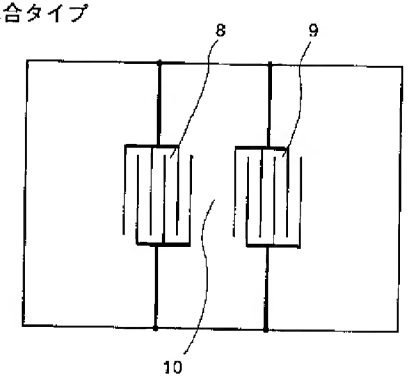
(c)



[Drawing 9]

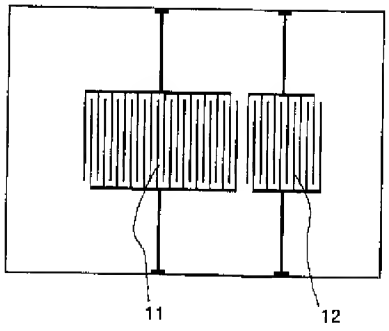
総合タイプ

(a)

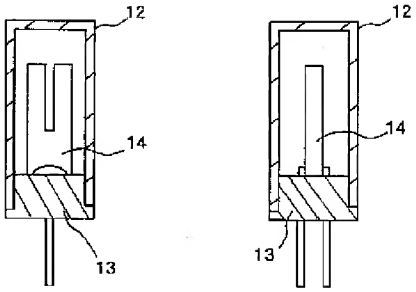


トランスバーサルタイプ

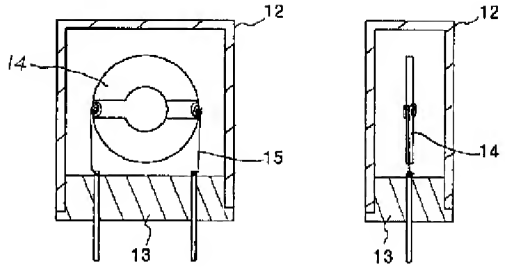
(b)



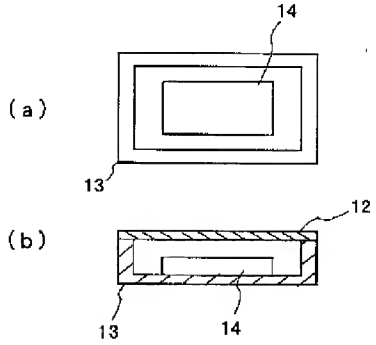
[Drawing 10]



[Drawing 11]



[Drawing 12]



[Translation done.]